THE HIDDEN INFRASTRUCTURE CRISIS:

POWER, WATER, AND LAND IN THE AGE OF ARTIFICIAL INTELLIGENCE

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POWER	WATER	LAND	INFRASTRUCTURE	SUSTAINABILITY
Rising electricity demand for AI and data centers	Water scarcity and cooling challenges	Land use pressure and environmental impact	Transmission, equipment, and supply chain risks	Building a resilient, efficient, and responsible future

OBJECTIVE

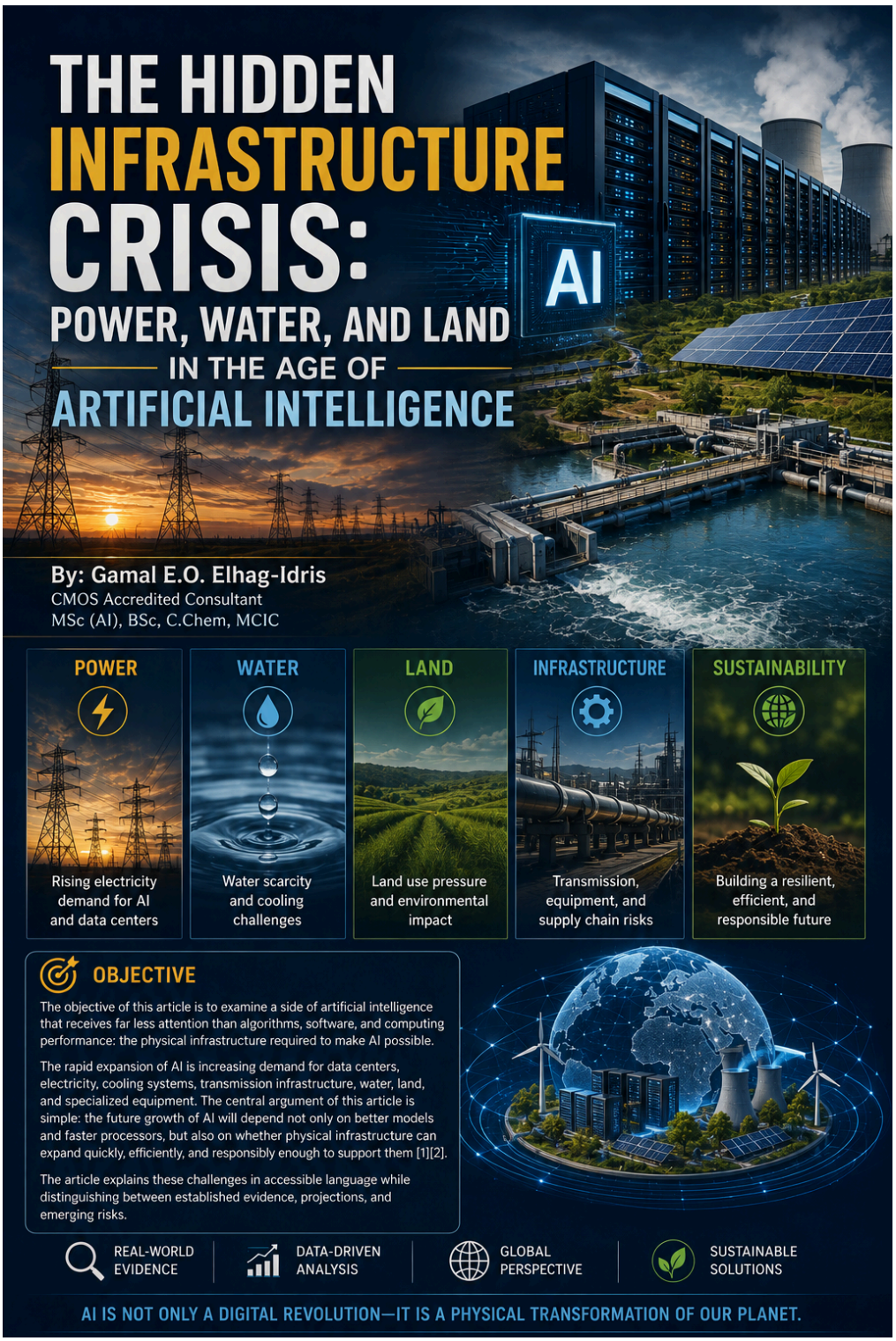
The objective of this article is to examine a side of artificial intelligence that receives far less attention than algorithms, software, and computing performance: the physical infrastructure required to make AI possible.

The rapid expansion of AI is increasing demand for data centers, electricity, cooling systems, transmission infrastructure, water, land, and specialized equipment. The central argument of this article is simple: the future growth of AI will depend not only on better models and faster processors, but also on whether physical infrastructure can expand quickly, efficiently, and responsibly enough to support them [1][2].

The article explains these challenges in accessible language while distinguishing between established evidence, projections, and emerging risks.

REAL-WORLD EVIDENCE | DATA-DRIVEN ANALYSIS | GLOBAL PERSPECTIVE | SUSTAINABLE SOLUTIONS

AI IS NOT ONLY A DIGITAL REVOLUTION—IT IS A PHYSICAL TRANSFORMATION OF OUR PLANET.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Abstract

Artificial intelligence may appear to be an entirely digital technology, but every AI calculation takes place somewhere in the physical world. Behind AI services are data centers containing processors, servers, storage systems, networking equipment, cooling systems, electrical infrastructure, and backup power equipment.

The International Energy Agency projects that global electricity consumption by data centers could approximately double from its 2024 level to about 945 terawatt-hours by 2030 under its base-case scenario. Electricity consumption associated with accelerated servers, driven mainly by AI adoption, is expected to grow particularly rapidly [1].

Electricity, however, is only one part of the infrastructure challenge. Data centers also produce large quantities of heat, making cooling essential. Depending on the cooling technology and local climate, this can create significant water requirements. Their construction also requires land, substations, transmission capacity, backup systems, roads, and other supporting infrastructure. Recent developments have consequently brought data-center projects into debates over grid capacity, water availability, environmental impacts, planning approvals, and community interests [2][3][4].

AI therefore has a physical footprint that must be considered alongside its digital benefits.

Article Topics

1. The Physical Reality Behind Artificial Intelligence
2. The Rapid Expansion of Data Centers
3. Electricity: The First Major Infrastructure Constraint
4. Why Power Grids Are Becoming a Bottleneck
5. The Water Footprint of AI Infrastructure
6. Land Use and the Expanding Physical Footprint
7. Communities, Planning, and Public Resistance
8. The Environmental Dimension
9. Building More Sustainable AI Infrastructure
10. The Need for Better Measurement and Transparency

Introduction

Artificial intelligence is often described as though it exists somewhere in an invisible digital world.

We speak about algorithms, models, cloud computing, machine learning, and automated systems. Yet none of these technologies operates without physical infrastructure.

Every AI model must run on computers. Those computers must be installed somewhere. They require electricity. They produce heat. That heat must be removed. Electricity must reach the facility through a grid or another power source. Cooling may require water. The facility itself requires land, electrical substations, networking equipment, backup power, and connections to surrounding infrastructure [1][2].

This physical reality is becoming increasingly important as AI deployment accelerates.

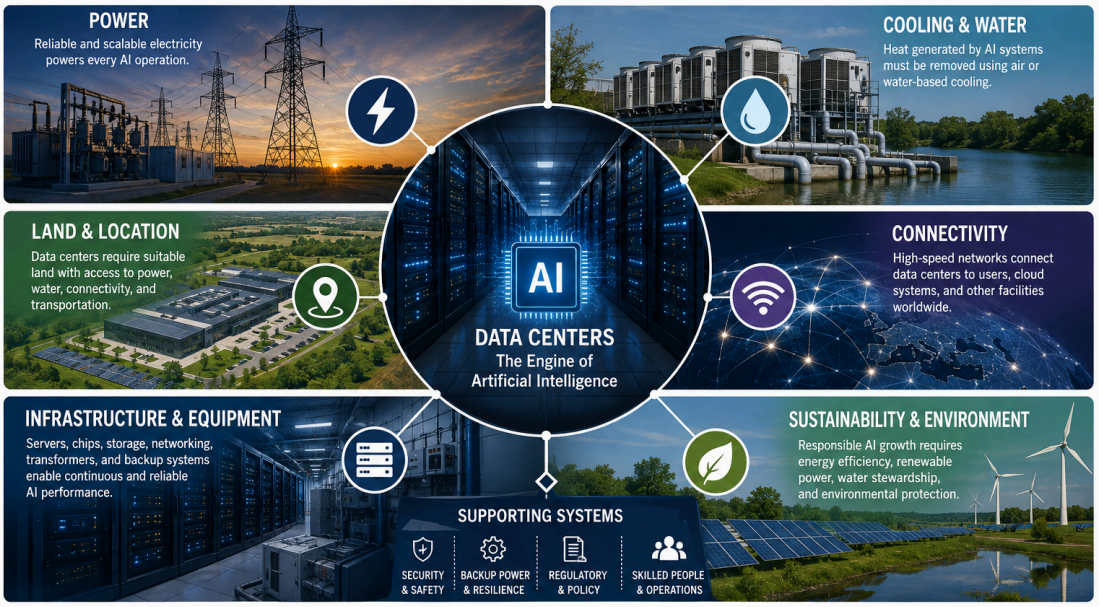
The International Energy Agency reported in April 2026 that electricity consumption by data centers rose by about 17 percent during 2025, while electricity use at AI-focused data centers increased even faster. The agency also reported that infrastructure bottlenecks involving electricity systems, transformers, generation equipment, advanced computing components, grid connections, and regulatory approvals were increasingly affecting how quickly new computing capacity could be deployed [2].

The next phase of the AI revolution, therefore, will not be determined by software alone.

It will also depend on power, water, land, engineering, construction, environmental management, and public policy (see Figure 1).

Figure 1. The Physical Infrastructure Behind Artificial Intelligence

AI Runs on Physical Systems: Power, Water, Land, and Engineering


POWER
Reliable and scalable electricity powers every AI operation.
COOLING & WATER
Heat generated by AI systems must be removed using air or water-based cooling.
LAND & LOCATION
Data centers require suitable land with access to power, water, connectivity, and transportation.
AI
DATA CENTERS
The Engine of Artificial Intelligence
CONNECTIVITY
High-speed networks connect data centers to users, cloud systems, and other facilities worldwide.
INFRASTRUCTURE & EQUIPMENT
Servers, chips, storage, networking, transformers, and backup systems enable continuous and reliable AI performance.
SUSTAINABILITY & ENVIRONMENT
Responsible AI growth requires energy efficiency, renewable power, water stewardship, and environmental protection.
SUPPORTING SYSTEMS
SECURITY & SAFETY
BACKUP POWER & RESILIENCE
REGULATORY & POLICY
SKILLED PEOPLE & OPERATIONS

AI is not just a software revolution — it is a physical infrastructure transformation.

1. The Physical Reality Behind Artificial Intelligence

An AI system may respond to a user within seconds, but producing that response involves a chain of physical processes.

A request travels through communications networks to computing infrastructure where processors perform calculations. Servers consume electricity while performing those calculations, and part of that electrical energy ultimately becomes heat. Cooling equipment then removes that heat so that the hardware can continue operating safely.

At a small scale, this process may seem insignificant.

At the scale of millions of users, large models, expanding AI services, and increasingly complex workloads, the infrastructure requirements become substantial.

This is why the AI discussion is gradually moving beyond the question:

How powerful can the next generation of AI become?

Another question is becoming equally important:

Where will the electricity and infrastructure needed to operate it come from?

The IEA estimates that global data-center electricity consumption could reach roughly 945 TWh by 2030 in its base case, compared with about 415 TWh in 2024. This would still represent less than 3 percent of total global electricity consumption, but the important issue is the speed and geographical concentration of the increase [1].

In other words, the global percentage alone does not tell the whole story.

A large new electricity load concentrated in one city or power system can create a much greater local challenge than the global figure suggests.

2. The Rapid Expansion of Data Centers

The data center is becoming one of the defining industrial facilities of the AI era.

Traditional data centers already supported websites, banking systems, streaming services, cloud storage, telecommunications, scientific computing, and business applications. AI adds another rapidly growing source of computational demand.

The IEA reported in 2026 that investment in data centers had continued to accelerate and that electricity demand associated with them was rising substantially faster than overall global electricity demand [2].

The United States provides a useful illustration of the scale of the change. A major study prepared by Lawrence Berkeley National Laboratory for the U.S. Department of Energy found that data-center electricity demand had increased sharply and could double or triple by 2028 relative to recent levels, depending on the development scenario [3][4].

This expansion is changing the way data centers are viewed.

They are no longer simply information-technology facilities.

At sufficient scale, they are also major industrial electricity consumers requiring coordination between digital infrastructure, utilities, grid planners, land-use authorities, water managers, and local communities.

3. Electricity: The First Major Infrastructure Constraint

Electricity is arguably the most immediate physical constraint facing rapid AI expansion.

AI processors must be powered continuously when operating. Cooling systems, networking equipment, storage systems, pumps, fans, lighting, power-conversion equipment, and other supporting systems also consume electricity.

According to the IEA, accelerated servers—whose growth is mainly associated with AI—are expected to account for a substantial share of the increase in data-center electricity consumption through 2030 [1].

This creates an unusual infrastructure problem.

Building a computing facility can sometimes be accomplished more quickly than expanding the electricity system required to supply it.

Power stations, transmission lines, substations, transformers, and grid interconnections may require years of planning, permitting, manufacturing, financing, and construction.

That mismatch is increasingly important.

The IEA reported in 2026 that the growing pipeline of data-center projects was placing pressure on planning systems, electricity connections, supply chains, transformers, and generation equipment [2].

The AI infrastructure challenge therefore cannot be solved simply by purchasing additional computing hardware.

A processor without sufficient electricity is unused capacity.

4. Why Power Grids Are Becoming a Bottleneck

Electricity grids were not designed with unlimited spare capacity.

They must constantly balance generation and demand while maintaining voltage, frequency, reliability, and safety. Adding very large electrical loads

can require upgrades to transmission lines, substations, transformers, generation capacity, and grid-management systems.

The problem becomes particularly difficult when many proposed facilities seek connections in the same region.

Recent developments show that this is no longer a theoretical concern. In several jurisdictions, authorities have begun reconsidering, delaying, restricting, or more closely examining large data-center developments because of concerns involving electricity demand, water consumption, land use, and infrastructure impacts [5][6].

This does not mean that data centers are inherently incompatible with reliable power systems.

It means that location and planning matter.

A facility built where generation and transmission capacity are abundant may have a very different impact from an equally large facility constructed in an already constrained electricity system.

Future AI infrastructure planning will therefore need to consider not only computing performance but also:

available generation capacity, transmission capacity, grid reliability, connection timelines, energy prices, local demand growth, and opportunities for energy storage and flexible operation [1][2].

5. The Water Footprint of AI Infrastructure

Electricity receives most of the attention, but water is another important part of the data-center discussion.

Computer processors generate heat. If that heat is not removed effectively, equipment performance and reliability can suffer.

Data centers therefore require carefully engineered cooling systems.

Not every data center uses the same amount of water. Water consumption depends on factors such as cooling design, climate, facility size, workload, operating temperature, and whether air cooling, evaporative cooling, liquid cooling, closed-loop systems, reclaimed water, or other technologies are used.

There is also an important distinction between **direct** and **indirect** water consumption.

Direct water consumption occurs at the data center itself, particularly where water is used in cooling.

Indirect water consumption can occur elsewhere in the system, including in the production of electricity used by the facility.

The environmental significance of these demands depends strongly on location. Water consumption in a water-abundant region is not equivalent to the same consumption in a drought-prone or water-stressed area.

The United Nations warned in 2026 that the expanding environmental footprint of AI infrastructure could create increasing pressures on water, land, energy, and climate if growth is not managed sustainably [7].

This makes water efficiency a strategic issue rather than simply an engineering detail.

6. Land Use and the Expanding Physical Footprint

A data center occupies more than the floor space containing servers.

Large facilities may also require electrical substations, cooling equipment, backup power systems, security areas, access roads, telecommunications infrastructure, fuel storage or other resilience systems, and surrounding utility infrastructure.

Some developments involve multiple buildings arranged as large campuses.

Land requirements can therefore become an important planning issue, particularly near growing cities or in regions where industrial land is already limited.

The physical footprint may extend beyond the property boundary.

New transmission infrastructure, substations, water connections, roads, and other services may be required to support the facility.

This is why the environmental footprint of AI should not be measured only by the physical size of computer rooms.

Its wider infrastructure footprint matters as well [7].

7. Communities, Planning, and Public Resistance

The expansion of data centers is increasingly becoming a local political and planning issue.

Communities may welcome construction activity, tax revenue, infrastructure investment, and economic development. At the same time, residents may raise legitimate questions about electricity demand, water consumption, noise, backup generators, visual impact, land use, electricity prices, environmental effects, and who pays for infrastructure upgrades.

These concerns have already influenced public policy.

Reuters reported in July and August 2026 that authorities in several jurisdictions had introduced restrictions, pauses, tighter reviews, or new conditions affecting large data-center developments. Concerns included electricity consumption, water demand, land use, pollution, and broader effects on communities and infrastructure [5][6].

This development carries an important lesson.

Technical feasibility does not automatically create social acceptance.

Future data-center development will increasingly require transparent communication with communities and clear answers to practical questions:

How much electricity will the facility require?

Where will that electricity come from?

How much water will be consumed?

Will additional grid infrastructure be necessary?

Who will pay for those upgrades?

What happens during drought, heat waves, or periods of high electricity demand?

These questions should be addressed before construction, not after conflict begins.

8. The Environmental Dimension

AI infrastructure presents an environmental challenge, but the issue requires careful interpretation.

Data centers are not responsible for most global electricity consumption. The IEA projects that even with rapid growth, their share of worldwide electricity demand will remain relatively limited compared with the entire global energy system [1].

However, their electricity consumption is growing rapidly.

The environmental consequences depend heavily on how that electricity is generated.

If additional demand is supplied primarily by low-carbon electricity, the emissions impact will be different from a system dependent heavily on fossil fuels.

The IEA expects renewable energy to supply a large share of additional electricity demand from data centers through 2030, but natural gas and coal are also expected to contribute significantly to meeting near-term growth [8].

This means the environmental question is not simply:

How much electricity does AI consume?

The more useful question is:

How much electricity does it consume, where is it consumed, when is it consumed, and how is that electricity generated?

That distinction is essential for serious environmental analysis.

9. Building More Sustainable AI Infrastructure

The solution is not to choose between technological development and environmental protection.

The more practical objective is to make digital infrastructure more efficient and more compatible with the physical systems supporting it.

Several approaches can help.

More efficient processors and software can reduce electricity required for a given amount of computation. Improved cooling systems can reduce energy and water consumption. Reclaimed or non-potable water may reduce pressure on drinking-water systems where technically and environmentally appropriate. Better siting can place facilities closer to available generation and transmission capacity.

Waste heat may also be recovered in suitable locations rather than simply released into the environment.

Renewable generation, energy storage, nuclear energy in some jurisdictions, improved transmission infrastructure, and flexible demand management may all form part of the longer-term solution [1][8].

Efficiency, however, should not be treated as a complete solution.

When computing demand grows faster than efficiency improves, total resource consumption can still rise.

Sustainable AI therefore requires both technological efficiency and responsible infrastructure planning.

10. The Need for Better Measurement and Transparency

One of the biggest difficulties in evaluating AI's environmental footprint is the lack of standardized public information.

Data-center designs differ. Workloads differ. Cooling technologies differ. Local climates differ. Electricity sources differ.

Simple statements such as "one AI query uses this much water" or "one AI response consumes this much electricity" can therefore be misleading when presented without assumptions and context.

A stronger approach is to measure facilities using transparent indicators covering electricity consumption, energy efficiency, water use, carbon intensity, renewable-energy sourcing, cooling performance, and resource conditions in the surrounding region.

Regulators are already moving in this direction.

The European Commission has established reporting requirements for qualifying data centers under its energy-efficiency framework, including information relevant to energy performance and water footprint [9].

Better measurement will allow governments, researchers, operators, and communities to distinguish between genuinely efficient infrastructure and environmental claims that lack sufficient evidence.

Discussion

The rise of artificial intelligence is exposing a fundamental reality about technological progress: digital growth cannot be separated from the physical world.

For decades, computing became smaller, faster, and more efficient. This encouraged the impression that digital technology was becoming almost weightless.

AI is challenging that assumption.

The enormous computational requirements associated with advanced AI have brought electricity generation, transformers, transmission lines, cooling systems, water availability, industrial land, and construction schedules directly into the technology debate [1][2].

This does not mean that an unavoidable global infrastructure crisis has already occurred. The evidence supports a more careful conclusion.

The risk is **regional and structural**.

Global electricity systems may be capable of supplying growing data-center demand, but individual regions can still experience serious bottlenecks when demand grows faster than local generation, transmission, water systems, or planning processes can adapt.

This distinction is important.

The central challenge is not simply whether the world possesses enough electricity, water, or land in total. The challenge is whether these resources are available **in the right places, at the right time, through infrastructure capable of delivering them sustainably**.

That is where the future of AI infrastructure will increasingly be decided.

Summary

Artificial intelligence has a physical foundation.

Its expansion requires processors, servers, data centers, electricity generation, transmission systems, cooling equipment, water in some cooling configurations, land, and supporting infrastructure.

Current evidence shows that data-center electricity consumption is growing rapidly, with AI contributing significantly to that increase. The IEA expects global data-center electricity consumption to approximately double by 2030 under its base-case projection [1].

At the same time, grid connections, power equipment, water considerations, planning approvals, and local community concerns are becoming increasingly important constraints [2][5][6] (see Figure 2).

The challenge is therefore not simply to build more computing capacity.

It is to build computing capacity that the physical world can support.

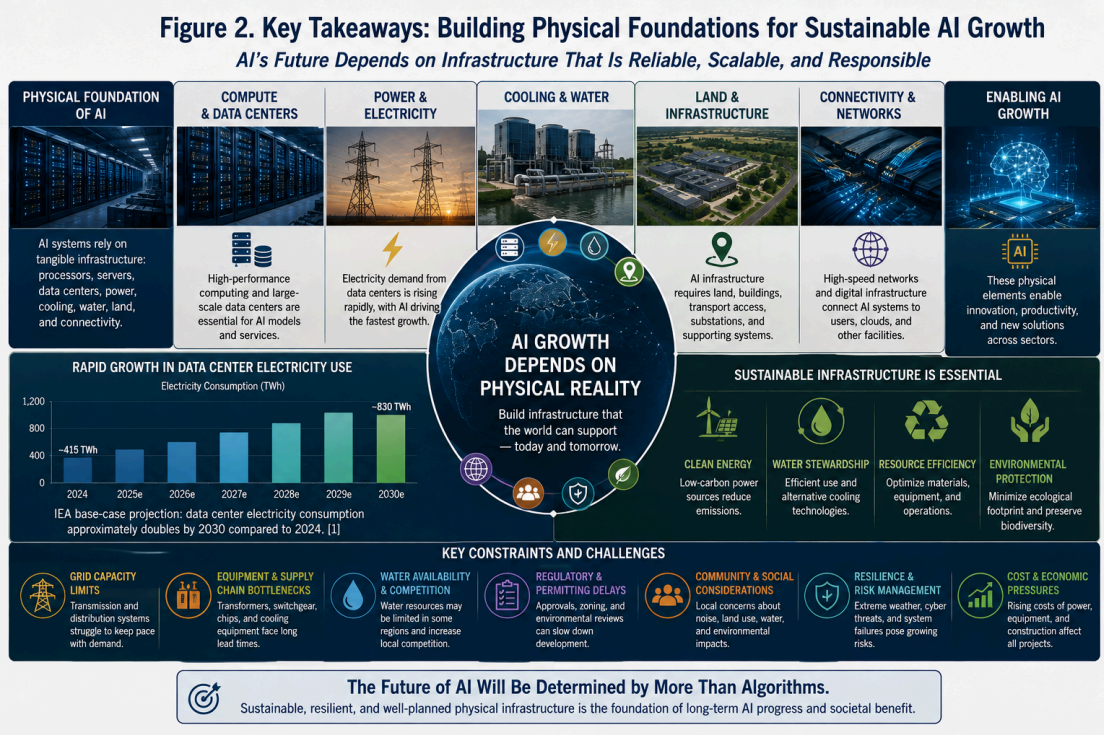


Figure 2. Key Takeaways: Building Physical Foundations for Sustainable AI Growth
AI's Future Depends on Infrastructure That Is Reliable, Scalable, and Responsible
PHYSICAL FOUNDATION OF AI
AI systems rely on tangible infrastructure: processors, servers, data centers, power, cooling, water, land, and connectivity.
COMPUTE & DATA CENTERS
High-performance computing and large-scale data centers are essential for AI models and services.
POWER & ELECTRICITY
Electricity demand from data centers is rising rapidly, with AI driving the fastest growth.
COOLING & WATER
LAND & INFRASTRUCTURE
AI infrastructure requires land, buildings, transport access, substations, and supporting systems.
CONNECTIVITY & NETWORKS
High-speed networks and digital infrastructure connect AI systems to users, clouds, and other facilities.
ENABLING AI GROWTH
These physical elements enable innovation, productivity, and new solutions across sectors.
AI GROWTH DEPENDS ON PHYSICAL REALITY
Build infrastructure that the world can support — today and tomorrow.
RAPID GROWTH IN DATA CENTER ELECTRICITY USE
Electricity Consumption (TWh)
1,200
800
400
0
~415 TWh
~830 TWh
2024
2025e
2026e
2027e
2028e
2029e
2030e
IEA base-case projection: data center electricity consumption approximately doubles by 2030 compared to 2024. [1]
SUSTAINABLE INFRASTRUCTURE IS ESSENTIAL
CLEAN ENERGY
Low-carbon power sources reduce emissions.
WATER STEWARDSHIP
Efficient use and alternative cooling technologies.
RESOURCE EFFICIENCY
Optimize materials, equipment, and operations.
ENVIRONMENTAL PROTECTION
Minimize ecological footprint and preserve biodiversity.
KEY CONSTRAINTS AND CHALLENGES
GRID CAPACITY LIMITS
Transmission and distribution systems struggle to keep pace with demand.
EQUIPMENT & SUPPLY CHAIN BOTTLENECKS
Transformers, switchgear, chips, and cooling equipment face long lead times.
WATER AVAILABILITY & COMPETITION
Water resources may be limited in some regions and increase local competition.
REGULATORY & PERMITTING DELAYS
Approvals, zoning, and environmental reviews can slow down development.
COMMUNITY & SOCIAL CONSIDERATIONS
Local concerns about noise, land use, water, and environmental impacts.
RESILIENCE & RISK MANAGEMENT
Extreme weather, cyber threats, and system failures pose growing risks.
COST & ECONOMIC PRESSURES
Rising costs of power, equipment, and construction affect all projects.
The Future of AI Will Be Determined by More Than Algorithms.
Sustainable, resilient, and well-planned physical infrastructure is the foundation of long-term AI progress and societal benefit.

Conclusion

Artificial intelligence is often described as a revolution in information.

It is also becoming a revolution in infrastructure.

The next generation of AI will depend on more than better algorithms and more powerful processors. It will depend on electricity generation, stronger grids, transformers, cooling technology, water management, land-use planning, efficient hardware, transparent environmental reporting, and cooperation with the communities where infrastructure is built.

The most important lesson is straightforward:

There is no artificial intelligence without physical infrastructure.

If AI continues expanding at its present pace, energy engineers, environmental scientists, water specialists, grid planners, architects, regulators, and local communities will become as important to its long-term development as computer scientists (see Figure 3).

The challenge is not to stop technological progress. It is to ensure that progress can be supported by the physical environment on which it ultimately depends.

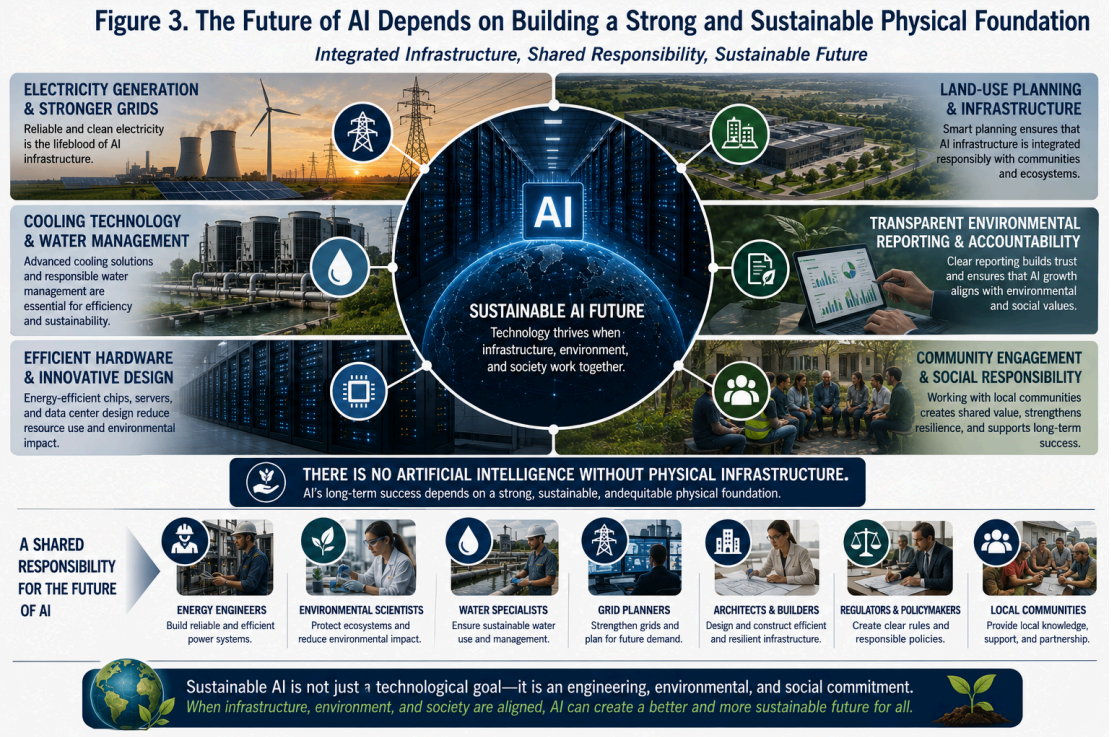


Figure 3. The Future of AI Depends on Building a Strong and Sustainable Physical Foundation
Integrated Infrastructure, Shared Responsibility, Sustainable Future
ELECTRICITY GENERATION & STRONGER GRIDS
Reliable and clean electricity is the lifeblood of AI infrastructure.
LAND-USE PLANNING & INFRASTRUCTURE
Smart planning ensures that AI infrastructure is integrated responsibly with communities and ecosystems.
AI
SUSTAINABLE AI FUTURE
Technology thrives when infrastructure, environment, and society work together.
COOLING TECHNOLOGY & WATER MANAGEMENT
Advanced cooling solutions and responsible water management are essential for efficiency and sustainability.
TRANSPARENT ENVIRONMENTAL REPORTING & ACCOUNTABILITY
Clear reporting builds trust and ensures that AI growth aligns with environmental and social values.
EFFICIENT HARDWARE & INNOVATIVE DESIGN
Energy-efficient chips, servers, and data center design reduce resource use and environmental impact.
COMMUNITY ENGAGEMENT & SOCIAL RESPONSIBILITY
Working with local communities creates shared value, strengthens resilience, and supports long-term success.
THERE IS NO ARTIFICIAL INTELLIGENCE WITHOUT PHYSICAL INFRASTRUCTURE.
AI's long-term success depends on a strong, sustainable, andequitable physical foundation.
A SHARED RESPONSIBILITY FOR THE FUTURE OF AI
ENERGY ENGINEERS
Build reliable and efficient power systems.
ENVIRONMENTAL SCIENTISTS
Protect ecosystems and reduce environmental impact.
WATER SPECIALISTS
Ensure sustainable water use and management.
GRID PLANNERS
Strengthen grids and plan for future demand.
ARCHITECTS & BUILDERS
Design and construct efficient and resilient infrastructure.
REGULATORS & POLICYMAKERS
Create clear rules and responsible policies.
LOCAL COMMUNITIES
Provide local knowledge, support, and partnership.
Sustainable AI is not just a technological goal—it is an engineering, environmental, and social commitment.
When infrastructure, environment, and society are aligned, AI can create a better and more sustainable future for all.

Terms Used and Their Meanings

Artificial Intelligence (AI): Computer systems designed to perform tasks that normally require aspects of human intelligence, including language processing, pattern recognition, prediction, reasoning, and content generation.

AI Data Center: A data center containing computing infrastructure designed or heavily used for training, operating, or serving artificial-intelligence systems.

Data Center: A physical facility containing servers, storage systems, networking equipment, electrical systems, cooling equipment, and related infrastructure used to process, store, or distribute digital information.

Accelerated Server: A server equipped with specialized computing hardware designed to perform computationally intensive workloads more efficiently than conventional general-purpose processors.

Inference: The stage in which a trained AI model processes new input and generates an output, prediction, classification, or response.

Training: The computational process through which an AI model learns patterns from data by adjusting its internal parameters.

Power Grid: The interconnected system of electricity generation, transmission, substations, distribution networks, and control equipment used to supply electricity.

Grid Connection: The physical and regulatory process through which a new electricity consumer or generator is connected to the power system.

Cooling System: Equipment used to remove heat produced by servers and other computing equipment.

Direct Water Use: Water consumed or withdrawn at the data-center facility itself.

Indirect Water Use: Water associated with activities outside the facility that support its operation, such as certain forms of electricity generation.

Water Stress: A condition in which demand for usable water approaches or exceeds available supply, or where water quality restricts its availability.

Infrastructure Bottleneck: A limitation in physical systems or supply chains that prevents demand from being met as quickly as required.

Terawatt-hour (TWh): A unit of electrical energy equal to one billion kilowatt-hours.

Waste-Heat Recovery: Capturing heat produced by equipment and using it for another purpose, such as heating nearby buildings or industrial processes.

References

[1] International Energy Agency. *Energy and AI*. Paris: IEA, 2025. See especially “Energy Demand from AI.”
IEA — Energy and AI

[2] International Energy Agency. *Key Questions on Energy and AI*. Paris: IEA, April 16, 2026.
IEA — Key Questions on Energy and AI

[3] Shehabi, Arman, Sarah Josephine Smith, Alex Hubbard, Alexander Newkirk, Nuoa Lei, Md AbuBakar Siddik, Billie Holecek, Jonathan G. Koomey, Eric R. Masanet, and Dale A. Sartor. *2024 United States Data Center Energy Usage Report*. Lawrence Berkeley National Laboratory, 2024. doi:10.71468/P1WC7Q.
Lawrence Berkeley National Laboratory — 2024 U.S. Data Center Energy Usage Report

[4] U.S. Department of Energy. “DOE Releases New Report Evaluating Increase in Electricity Demand from Data Centers.” December 20, 2024.
U.S. Department of Energy — Data Center Electricity Demand Report

[5] Reuters. “Authorities Restricting Data Centres amid AI Boom.” July 14, 2026. The report documents regulatory and community responses concerning electricity, water, land, and infrastructure pressures associated with large data centers. (Reuters)

[6] Reuters. “Texas Governor Orders Pause on New Data Center Approvals Pending Audit.” August 4, 2026. The report describes heightened scrutiny of proposed data-center grid connections and requirements concerning energy, water, and community impacts. (Reuters)

[7] United Nations. “AI’s Environmental Costs Threaten Water, Land and Climate.” June 4, 2026.
United Nations — AI’s Environmental Costs

[8] International Energy Agency. “Energy Supply for AI.” In *Energy and AI*. Paris: IEA, 2025.
IEA — Energy Supply for AI

[9] European Commission. “Energy Performance of Data Centres.” Directorate-General for Energy. The EU framework includes monitoring and reporting of data-center energy performance and water-footprint indicators.
European Commission — Energy Performance of Data Centres

Article Description

The Hidden Infrastructure Crisis: Power, Water, and Land in the Age of Artificial Intelligence

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Artificial intelligence may seem like something that exists only on computers and the internet, but behind every AI system is a large and growing physical infrastructure.

AI depends on data centers filled with powerful computer processors and servers. These facilities need electricity to operate, cooling systems to control the heat produced by computing equipment, water in some cooling systems, and land for buildings, electrical substations, backup power, roads, and other supporting infrastructure.

This article explains this often-overlooked side of artificial intelligence in clear language for readers from different professional and educational backgrounds.

It examines how the rapid growth of AI is increasing electricity demand and why power grids and electrical infrastructure may become important limits on future data-center expansion. It also discusses the water needed for certain cooling technologies, the growing physical footprint of data-center campuses, environmental concerns, land-use pressures, and the questions being raised by communities where large facilities are proposed or constructed.

Water is an especially important part of this discussion. Powerful computer equipment produces considerable heat and must be cooled continuously while operating. Some cooling technologies use water directly, while additional water may be associated indirectly with electricity generation. The actual water footprint varies greatly depending on location, climate, cooling technology, electricity source, and facility design. For this reason, the article avoids treating all data centers as environmentally identical.

The article also examines possible solutions. These include more efficient computing hardware, improved cooling technologies, responsible water management, the use of reclaimed or non-potable water where appropriate, stronger electricity grids, cleaner energy sources, careful site selection, waste-heat recovery, and better public reporting of energy and water consumption.

One important message runs throughout the article:

Artificial intelligence is digital, but the infrastructure supporting it is physical.

The future of AI will therefore depend on more than faster processors and better software. It will also depend on electricity generation, power grids, transformers, cooling engineering, water availability, land-use planning, environmental management, and cooperation with local communities.

The article is based on published information from recognized scientific, governmental, and international sources. It also makes an important distinction between measured data and future projections. Estimates of AI-related electricity and resource demand may change as computing technology, energy efficiency, cooling methods, regulation, and patterns of AI use continue to develop.

The purpose is not to argue against artificial intelligence or data centers. Rather, it is to encourage a broader discussion about how technological progress can continue while using energy, water, land, and other natural resources responsibly.

AI may be changing the digital world, but its long-term future will also be shaped by how carefully we manage the physical world that supports it.

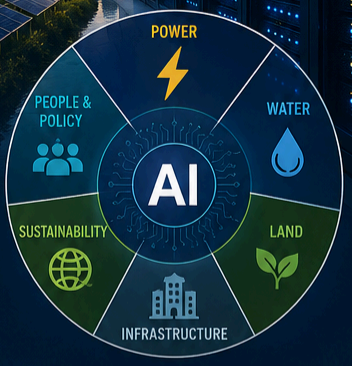
Keywords: Artificial Intelligence; AI Infrastructure; Data Centers; Electricity Demand; Power Grids; Water Consumption; Data-Center Cooling; Water Management; Wastewater Reuse; Energy Efficiency; Land Use; Environmental Sustainability; Sustainable Infrastructure; Digital Infrastructure; Resource Management.

THE HIDDEN INFRASTRUCTURE CRISIS:

POWER, WATER, AND LAND IN THE AGE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence is reshaping our world, but its true foundation lies far beyond algorithms and code. Behind every AI model and digital service stands an immense physical infrastructure—data centers, power plants, transmission grids, cooling systems, water resources, and land. These are the real enablers of AI.

This article uncovers the hidden infrastructure challenges that are already limiting AI growth and explores how the world can build sustainable solutions. Drawing on the latest global data, expert analysis, and practical insights, it explains in accessible language why the next phase of the AI revolution will be won or lost not just in the cloud—but on the ground.



WHAT YOU WILL DISCOVER

- Why AI is driving an unprecedented surge in electricity demand
- The overlooked challenge of water use for cooling
- How land, communities, and the environment are affected
- Critical infrastructure bottlenecks slowing down AI expansion
- The role of engineers, planners, scientists, and policymakers
- Real-world solutions for a sustainable AI future
- Actionable insights for professionals, leaders, and informed citizens

> *There is no artificial intelligence without physical infrastructure. The challenge is not to stop technology—but to build the foundation that makes progress possible.*

ABOUT THE AUTHOR

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Gamal E.O. Elhag-Idris is a multidisciplinary professional with expertise in artificial intelligence, chemistry, environmental sciences, and infrastructure systems. He holds a Master of Science in Artificial Intelligence and a Bachelor of Science in Chemistry.

As a CMOS Accredited Consultant, Chartered Chemist (C.Chem), and member of the Canadian Institute of Chemistry (MCIC), he combines scientific rigor with practical insight to analyze complex global challenges.

His work focuses on the intersection of technology, environment, and sustainability, with a mission to promote responsible innovation and evidence-based decision making for a better future.

MULTIDISCIPLINARY EXPERTISE
AI, infrastructure, energy, water, chemistry, and sustainability

DATA-DRIVEN APPROACH
Using global data and credible sources to inform analysis

SUSTAINABILITY FOCUS
Advocating for responsible growth and environmental stewardship

PRACTICAL INSIGHT
Bridging science, engineering, policy, and society

GLOBAL PERSPECTIVE
Addressing challenges with a long-term vision for all communities

WHO SHOULD READ THIS ARTICLE?

- Policymakers & Regulators
- Engineers & Infrastructure Professionals
- Researchers & Academics
- Industry Leaders & Investors
- Students & Informed Citizens

A sustainable AI future depends on more than innovation—it depends on the infrastructure we build today for the generations of tomorrow.